(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 October 2003 (09.10.2003)

PCT

(10) International Publication Number
WO 03/082355 A1

(51) International Patent Classification[7]: A61L 2/18, 2/20, 2/24

(21) International Application Number: PCT/GB03/01386

(22) International Filing Date: 28 March 2003 (28.03.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0207452.4 28 March 2002 (28.03.2002) GB
0211851.1 22 May 2002 (22.05.2002) GB

(71) Applicant *(for all designated States except US)*: **BIOQUELL UK LIMITED** [GB/GB]; Walworth Road, Andover, Hampshire SP10 5AA (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ADAMS, Nicholas, Mark, Turner** [GB/GB]; Cooks Farm, Clanville, Hampshire SP11 9HZ (GB). **WATLING, David** [GB/GB]; Heathcrest, Guildford Road, Westcott, Dorking, Surrey RH4 3LB (GB).

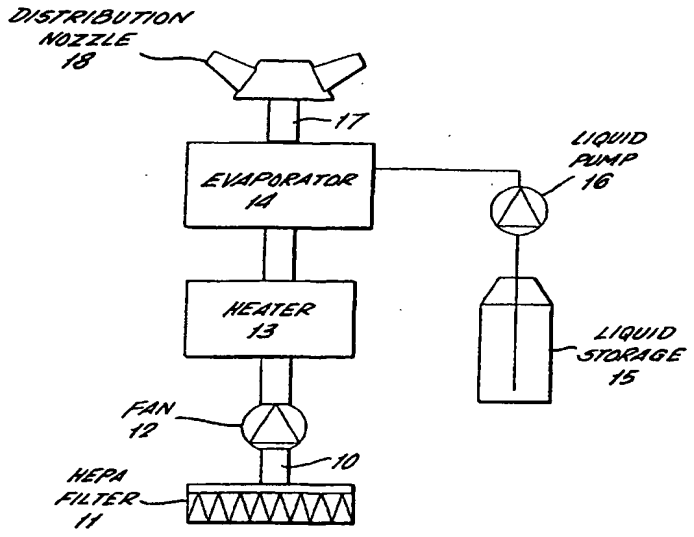
(74) Agents: **BAYLISS, Geoffrey, Cyril** et al.; Boult Wade Tennant, Verulam Gardens, 70 Gray's Inn Road, London WC1X 8BT (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: METHODS AND APPARATUS FOR DECONTAMINATING ENCLOSED SPACES



(57) Abstract: The disclosure relates to a portable apparatus for decontaminating an enclosed room or other space comprising a passageway (17) having an air inlet at one end and an outlet at the other end. A pump (12) to cause a flow of air through the passageway from the inlet to the outlet. A heater (13) to heat the air flowing through the passageway to a predetermined temperature, and a flash evaporator (14) in communication with the passageway. Liquid decontaminant is pumped (16) from a supply (15) of decontaminant to the evaporator (14) to be evaporated and for the evaporant to be delivered to the air flow in the passage (17) to flow in the air flow from the outlet to the rooms to be decontaminated. A universally rotating nozzle (18) is provided at the outlet to distribute the decontaminant containing air throughout the enclosure.

WO 03/082355 A1

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

The apparatus and method described in the present invention will work equally well with both the dry and condensation processes. When operating a dry process it is essential to monitor the water and hydrogen peroxide concentration in the gaseous phase to ensure that they remain below the saturated vapour concentrations. When operating a condensation process it is helpful to have an indication of the point during the cycle when condensation starts to form and the subsequent rate of formation. A technique and apparatus to make such a measurement of condensation is described patent application UK 0291983.1

An ideal bio-decontamination cycle is in three phases. The first phase is to bring all of the equipment to thermal stability but may also be used to adjust the relative humidity in the chamber to a pre-set level, the second is used to raise the gas concentration to the required level and maintain that concentration for a sufficient length of time to achieve the required level of bio-decontamination, and the third and last phase to reduce the concentration of the sterilant in the enclosed space to a predetermined value.

This invention provides an apparatus and method for decontaminating an enclosed space comprising a passageway having an air inlet at one end and an outlet at the other end, means to cause a flow of air through the passageway from the inlet to the outlet, means to heat the air flowing through the passageway to a predetermined temperature, evaporator means in communication with the passageway, means to delivery liquid decontaminant from a supply of decontaminant to the evaporator means to be evaporated thereby and for

the evaporant to be delivered to the air flow in the passage to flow in the air flow from the outlet to the rooms to be decontaminated.

By placing the gas generator inside the room and simply heating the carrier gas and then evaporating this sterilant into the air stream it is possible to use the available energy much more efficiently. The increase in efficiency is derived from the removal of the system for decomposing and drying the carrier gas, and also because there is no need for any pipe work to transport the carrier gas and decontaminant from an external generator.

This increased efficiency provides more energy for the primary function of heating the carrier gas and flash evaporating the liquid. The efficiency increase is so great as it allows a trebling of the rate of flash evaporation from the same energy source and hence the rate of increase in the gas concentration or the achievable rate of formation of condensation once the dew point has been reached is also trebled.

The simplified design is also much smaller and lighter than a conventional gas generator and hence considerably less expensive to manufacture. It is therefore realistic to place a number of such devices inside a sealed enclosure to be decontaminated. This reduction in size and weight makes the apparatus portable and hence makes it practical to use the same apparatus to bio-decontaminate a number of facilities either on the one site or at different locations. As stated above it is important to make measurements of

CLAIMS:

1. A method of decontaminating an enclosed space comprising the steps of creating within the enclosed space hydrogen peroxide/water vapour from an aqueous solution of hydrogen peroxide, generating a flow of heated air within the enclosed space, introducing the hydrogen peroxide/water vapour into the flow of heated air to be carried by the air flow, distributing the air flow carrying the hydrogen peroxide/water vapour throughout the enclosed space and over any surfaces in the enclosed space for a period of time sufficient to achieve bio-decontamination and then removing the hydrogen peroxide vapour from the enclosed space.

2. A method as claimed in claim 2, wherein hydrogen peroxide/water vapour is added to the flow of heated air circulated in the enclosure until the dew point of the vapour is reached and condensation of hydrogen peroxide/water vapour on the surfaces of the enclosure takes place following which the hydrogen peroxide is removed from the enclosed space.

3. A method as claimed in claim 2, wherein the measurement of the condensation of vapour is measured by a monitor and when the condensation has reached a requisite level, air flow containing hydrogen peroxide/water vapour is terminated.

4. A method as claimed in claim 2 or claim 3, wherein condensation is measured in the enclosure at a number of locations by condensation monitors to ensure that condensation has taken place throughout the enclosure.

5. A method as claimed in claim 1, wherein air carrying hydrogen peroxide/water vapour is introduced into the enclosure until a predetermined concentration of hydrogen peroxide/water vapour in the atmosphere in the enclosure has been reached after which introduction of the air is terminated and the hydrogen peroxide is removed.

6. A method as claimed in claim 5, wherein biological indicators are used in the enclosure to determine when the concentration of hydrogen peroxide/water vapour in the atmosphere in the enclosure has reached the requisite level following which the hydrogen peroxide is removed.

7. A method as claimed in any of the preceding claims, wherein the heated air carrying hydrogen peroxide/water vapour is delivered as a jet within the enclosure.

8. A method as claimed in claim 7, wherein the heated air carrying hydrogen peroxide/water vapour is delivered in a universally rotating jet to distribute the vapour throughout the enclosure.

9. A method as claimed in any of the preceding claims, wherein one or more fans are provided spaced from the delivery of air carrying hydrogen peroxide/ water vapour into the enclosure to deliver air carrying the vapour to remote locations of the enclosure from said source.

10. A method as claimed in any of the preceding claims, wherein the vapour of hydrogen peroxide and water also contains peracetic acid.

11. A method as claimed in claim any of claims 1 to 9, wherein the solution from which the hydrogen peroxide/water vapour is produced contains 30 to 35% hydrogen peroxide and a balance of water.

12. A method as claimed in claim 10, wherein the solution from which the hydrogen peroxide solution is produced comprises 15% hydrogen peroxide, 0.5% peracetic acid and a balance of water.

13. A method as claimed in any of the preceding claims, wherein hydrogen peroxide is removed by circulating the air containing hydrogen peroxide over a catalyst.

14. A method as claimed in any of claims 1 to 8, wherein the hydrogen peroxide is removed from the enclosure using the heating/ventilation air conditioning system for the room.

15. A method as claimed in any of the preceding claims, wherein a plurality of heated air flows are provided to which the hydrogen peroxide/water vapour is added to provide a plurality of flows of heated air carrying hydrogen peroxide/water vapour at different locations in the enclosure.

16. A method as claimed in any of the preceding claims, wherein the method is controlled from outside the enclosure.

17. A method as claimed in any of the preceding claims, wherein the air is dehumidified to reduce the relative humidity in the enclosure to a predetermined level prior to delivering heated air containing hydrogen peroxide/water vapour to the enclosure.

18. A method as claimed in claim 17, wherein the air is dehumidified using an air conditioned system for the enclosed space.

19. A method as claimed in any of the preceding claims, wherein a portable apparatus is used in the enclosure having a duct with a fan for delivering air through the duct, a filter for filtering air entering the duct, a heater for heating air passing through the duct and means for delivering hydrogen peroxide/water vapour to the air passing through the duct and a nozzle for delivery of air carrying hydrogen peroxide/water vapour from the duct, the nozzle being rotated universally to distribute the hydrogen peroxide/water vapours throughout the enclosure, circulation of air carrying the hydrogen peroxide/water vapour through the duct causing decontamination of the duct.

20. An apparatus for decontaminating an enclosed space comprising a duct to be positioned within the enclosed space having an inlet end and an outlet end, a fan for causing air to flow from the enclosed space through the duct, a filter for filtering air at the inlet end of the duct, means for delivering aqueous hydrogen peroxide solution to a heater to flash evaporate the aqueous hydrogen peroxide to produce hydrogen peroxide/water vapour which is entrained in the air flow passing through the duct, a nozzle at the

outlet end of the duct and means to rotate the nozzle universally to deliver hydrogen peroxide/water vapour throughout the enclosure, all internal and external surfaces of the apparatus open to the enclosure being exposed to the hydrogen peroxide/water vapour carrying air in the enclosure to decontaminate the surfaces.

21. An apparatus as claimed in claim 20, wherein the components of the apparatus are mounted in a support for transport of the apparatus.

22. An apparatus as claimed in claim 21, wherein the apparatus is a self-contained unit which is mobile or portable for movement from location to location where it is to be used.

23. An apparatus as claimed in claim 22, wherein the supply of hydrogen peroxide/water vapour and/or the nozzle and means to rotate the nozzle are readily removable for transport of the apparatus.

24. An apparatus as claimed in any of the preceding claims including a control box for controlling operation of the apparatus, wherein means are provided for delivering air carrying hydrogen peroxide/water vapour from the atmosphere in the enclosure around the control box through the control box to decontaminate inner surfaces of the control box.

25. An apparatus as claimed in any of the preceding claims including a separate monitoring unit for monitoring the temperature of the atmosphere in the enclosure and the concentration of hydrogen peroxide/ water vapour in the atmosphere, wherein means are

FIG. 4.

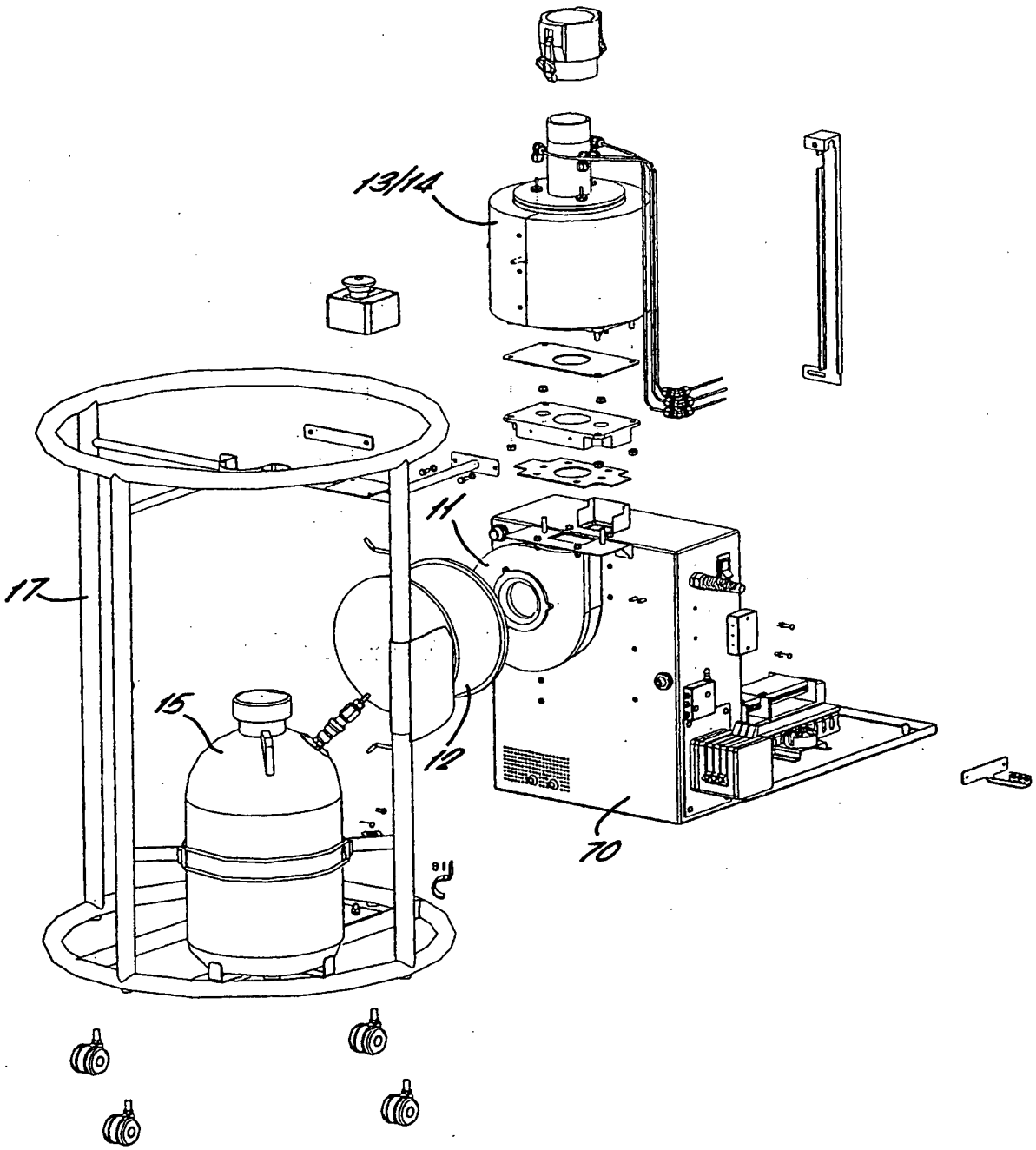


FIG. 5.

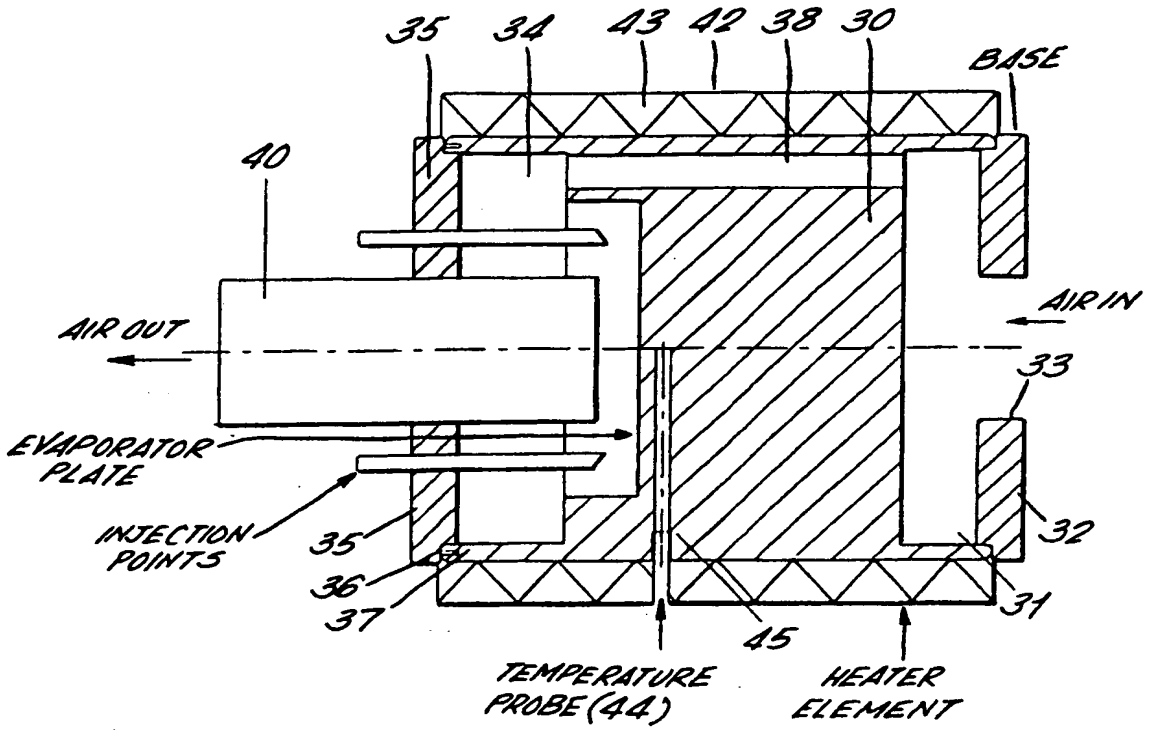


FIG. 6.